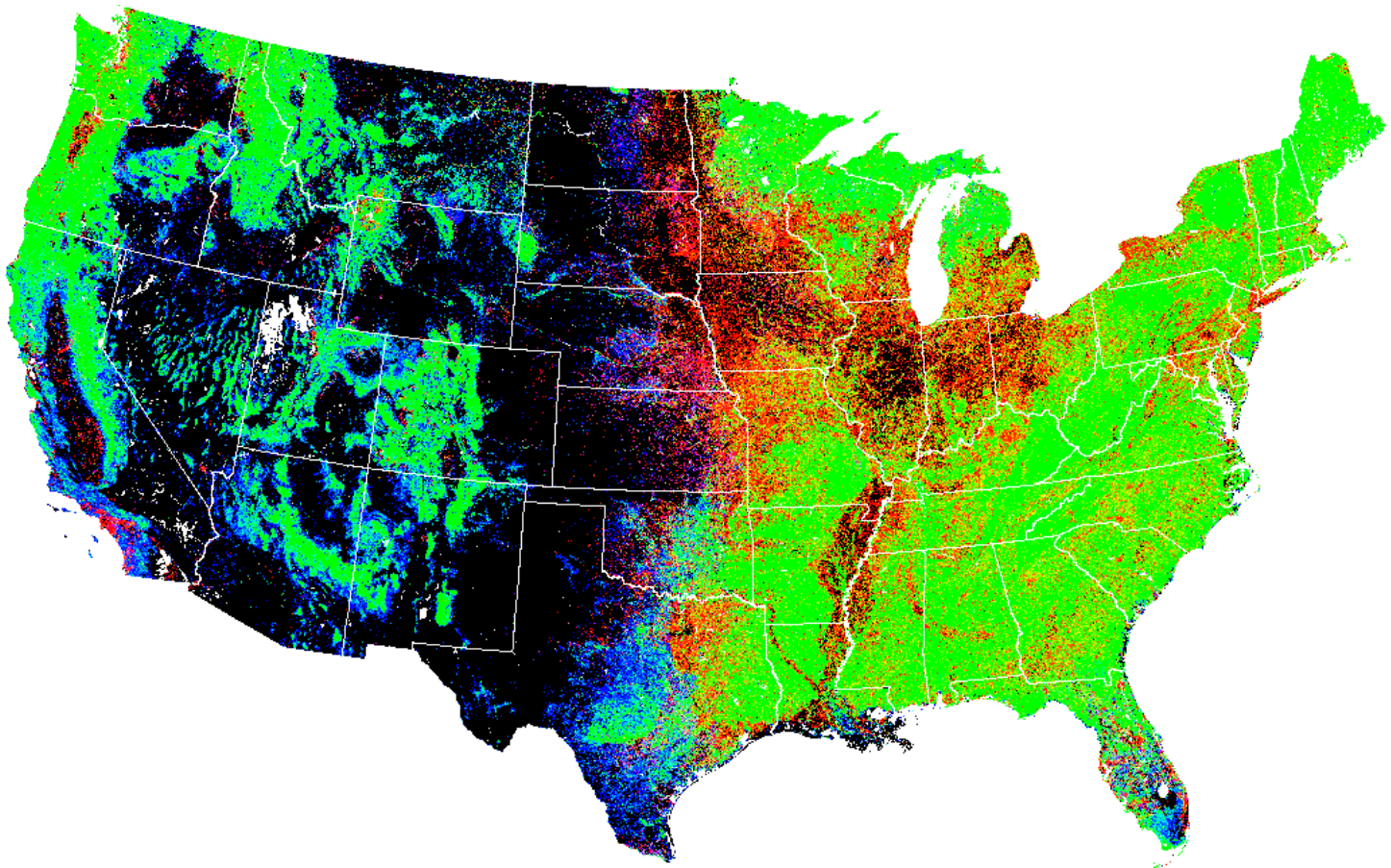


Forest Fragmentation

Differentiating between human and natural causes



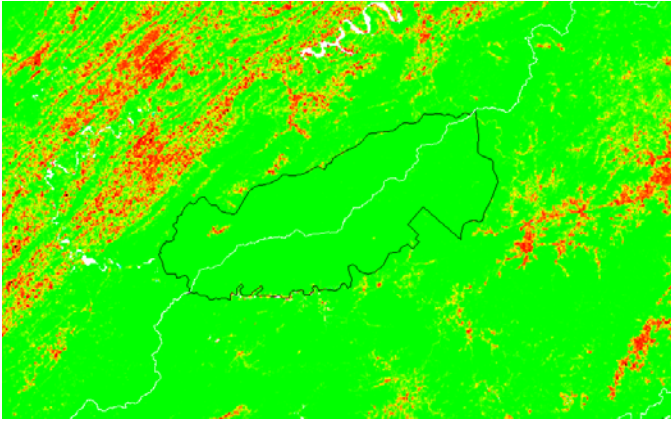
Forest fragmentation is the process of breaking up large patches of forest into smaller pieces. This can be caused by many things, from clearing forest for roads or development to wildfire. Forest fragmentation may reduce biodiversity by making it more difficult for some species to breed or find food. Forests act as filters, and removing forest near streams may adversely affect water quality and human drinking water supplies. Continued fragmentation can lead to deforestation, which may accelerate global warming by releasing carbon stored in trees.

Human land uses tend to expand over time, so forests that share a high proportion of their borders with anthropogenic uses (urban or agriculture) are at higher risk of further degradation than forests that share a high proportion of their borders with non-forest, natural land cover (wetland, grassland or shrubland). In cooperation with the U.S. Forest Service, EPA has developed a model to separate forest fragmentation into human and natural causes (detailed information about the method applied on a global scale can be found in Wade et al. 2003). The map of the conterminous United States above was derived from 1992 National Land Cover Data (NLCD; <http://www.epa.gov/mrlc>), which has cells about the size of a baseball diamond.

On the map pure green identifies areas of highly connected forest, blue areas show where forest is highly fragmented by another natural land-cover type and red areas are where forest is highly fragmented by a human land-use. Other colors are produced by different mixes of fragmentation. For example, yellow (red plus green) identifies areas with roughly equal amounts of connected forest and anthropogenic fragmentation. Areas of cyan (blue plus green) are where forest connectivity and natural fragmentation are fairly equal. Black represents areas with no forest, and white represents water bodies.

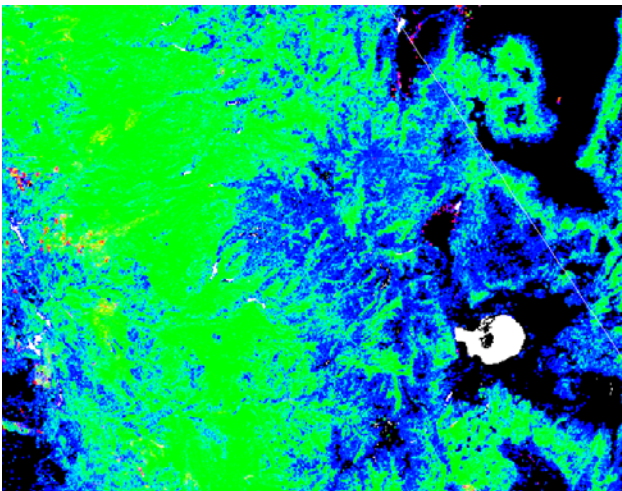
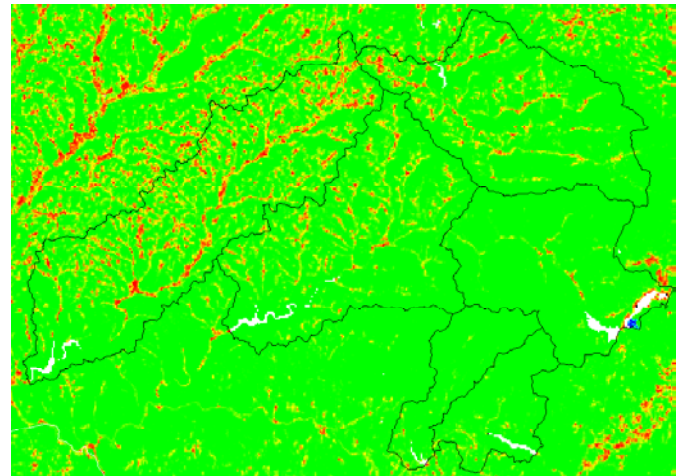
The eastern United States was nearly entirely forested at one time. Most fragmentation was subsequently caused by human development. Since the analysis ignored fragmentation by rivers and lakes, natural fragmentation is mostly limited to wetland areas along the coast and throughout Florida. Forests in the west are often naturally fragmented by grassland and shrubland, and are found in mountains where development is difficult. The center of the country, from North Dakota to Texas is the transition zone between the eastern forests and the Great Plains. In this region, a complex mixture of land cover results in all types of fragmentation.

Areas displayed in yellow represent transition zones between connected forest and human fragmented forest. With continued human land use expansion these areas are the most likely to experience further degradation. In time, the transition zones may become highly fragmented and new transitional areas will appear deeper in the intact forest. Consequently, the yellow areas on maps are at relatively greater risk of further fragmentation in the future and may represent excellent opportunities for protection or restoration. Protecting transitional and adjacent areas may limit further expansion or degradation of the transitional areas. Restoration efforts to reduce or eliminate fragmentation may produce larger patches of connected or interior forest.



This map of the Great Smoky Mountains National Park indicates development encroaching from the north, west, and east. Continued expansion of anthropogenic land use could threaten “pristine-like” conditions within the park boundaries. The only fragmentation in the park was found in Cades Cove, a preserved pioneer homestead that includes areas cleared of forest for pasture and farmland.

Most of the drinking water for New York City is provided by the reservoirs shown in white on this map. Currently, the water from these reservoirs does not require filtration. The area overall has relatively little human use, mostly agricultural, but this is changing as tourism encourages development in the form of vacation homes and resorts. Continued development may degrade water quality below standards, requiring further land protection or spending billions of dollars to build treatment facilities. See Mehaffey et al. (2001) for more information.



This is a map of the southern Sierra Nevada Mountains in California. Mono Lake is the white patch in the lower right. The large amount of cyan represents a transition zone between forest and other natural land cover types. These transitional areas between ecosystems are called ecotones. Because they have diverse characteristics, ecotones provide valuable habitat that can support many species. Similar to the yellow transitional areas, ecotones may be good candidates for protection.

Suggested reading:

Mehaffey, M.H., et al. 2001. *A Landscape Assessment of the Catskill/Delaware Watershed 1975-1998: New York City's Water Supply Watersheds*. United States Environmental Protection Agency Report, EPA/600/R-01/075.
 Riitters, K.H., et al. 2002. Fragmentation of Continental United States Forests. *Ecosystems*, 5:815-822.
 Wade, T.G., et al. 2003. Distribution and causes of global forest fragmentation. *Conservation Ecology* 7(2): 7. [online] URL: <http://www.consecol.org/vol7/iss2/art7>

For more information, contact:

Tim Wade
 U.S. EPA
 E243-05
 RTP, NC 27711
wade.timothy@epa.gov